



**Groom Design Services  
Ltd**

The Three Horseshoes  
Brierley  
Barnsley  
S72 9JT

**Phase II Geo  
Environmental Site  
Assessment**

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July 17

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## Revision Record

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## 1. Introduction

### 1.1. General Introduction

This Report presents the findings of a Phase II Geo-environmental assessment of a site at The Three Horseshoes (Grid Reference: 440701, 411228) for Groom Design Services Ltd.

The Intrusive Site Investigation (Phase II) comprised of boreholes to establish the sub surface strata and remove samples for contamination and geotechnical testing. The test results combined with the findings of the intrusions will then be used to make recommendations for any remedial works which may be necessary. A site plan including positions of the boreholes can be found in Appendix I of this report.

### 1.2. Objectives

The intrusive investigation was conducted to assess and confirm the immediate sub-surface ground conditions and extract in-situ soil samples for laboratory testing as recommended in Phase I Report dated June 2017 by Met Engineers Ltd, to determine the geotechnical and environmental position of the site.

### 1.3. Scope of Works

Based upon the recommendations of the Desk Study and a visual assessment of the sub-surface materials during the intrusive works, soil samples were taken for laboratory testing. CLEA Guidelines and recommendations given in Land Quality Management General Assessment Criteria have been applied to establish a risk based CLEA Model to assess the likely contamination issues and to comment on potential constraints for development of the site.

Judgement is based strictly on the findings of the specific boreholes and soil samples tested and therefore may not be representative of the site as a whole. The findings of the intrusive investigation will also be used in conjunction with the findings of the Desk Study to establish parameters which may be used in formulating a foundation design.

### 1.4. Limitations of the Report

Groom Design Services Ltd. (the Client) has requested that a Phase II Site Investigation, CLEA Conceptual Model and Risk Assessment be undertaken in order to assess the suitability of the site for redevelopment. The report is not a comprehensive site characterisation and should not be construed as such.

This report has been prepared for the sole internal use and reliance of Groom Design Services Ltd. The report shall not be relied upon or transferred to any other parties without the express written authority of Met Engineers Limited. If any unauthorised third party comes into possession of the report, they rely on it at their own risk and Met Engineers Limited owes them no duty of care.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report and which Met Engineers Limited, believes are reliable.

Nevertheless, Met Engineers Limited, cannot and does not guarantee the authenticity or reliability of the information it has relied upon. The information contained in this report is to the best of our knowledge accurate at the date of issue, however, sub-surface conditions, including ground water levels, may vary, especially with time.

In preparing this report it has been assumed that all past and present occupants and Third Parties have provided accurate information, especially relating to known or potential hazards. This report does not identify deficiencies or mistakes in the information provided by the user/owner, or from any other source, except where obvious in the light of other information.

This report is relevant at the date the report was written and should be read in the light of any subsequent changes in legislation, statutory requirement or industry practices.

The report represents the technical findings and opinions of Met Engineers Limited, and does not constitute any legal advice. As such, the advice of a Solicitor may also be required.

## 2. Site History and Environmental Setting

A detailed review of the published history, hydrological, geological and available environmental information was carried out by Met Engineers in a Phase I Desk Study report dated June 2017. The following is a brief summary of those findings.

The area of land referred to as 'The Site' within this document is indicated in Appendix I.

### 2.1. Site Description

<b>Site Name</b>	The Three Horseshoes, Brierley, Barnsley, S72 9JT
<b>Location</b>	Grid Reference: 440701, 411228
<b>Setting</b>	<p>The site is located adjacent to the currently disused Three Horseshoes pub in Brierley, approximately 7.8km north east of Barnsley. It is rectangular in shape and covers an area of approximately 0.15 hectares (Ha). The site is accessed via an open entrance off Barnsley Road.</p> <p>The site was previously used as a pub car park and is predominantly covered by hardstanding (tarmac) with trees and grass in the centre and along the western boundary. The site is currently vacant besides a temporary waste skip in the north east corner.</p> <p>The boundaries of the site are open to the east adjacent to The Three Hoeseshoes pub a with a stone wall running along the northern boundary adjacent to Barnsley Road. The western boundary is partially formed by the wooden fencing of the neighbouring house, the northern part of this boundary is currently open with a steep drop (approximately 1.5m) between the site and the adjacent driveway.</p> <p>The adjacent land uses are a disused pub to the east, Barnsley Road to the north, and residential houses with gardens to the south and west.</p>
<b>Site History</b>	<p>The earliest OS Maps show buildings and a public house present on the site by 1893. These remained until 1961 when the pub appears to the east of the site and all but one of the buildings have been demolished. The site has remained the same since 1977 when all buildings had been removed and a verge was present in the centre of the site.</p> <p>The surrounding area was previously generally agricultural with the village of Brierley to the east. The main changes to the surrounding area have been the various residential developments and expansion of the village of Brierley over the past century.</p>
<b>Development Proposals</b>	It is proposed to develop the site for residential use.

## 2.2. Geology & Soils

<b>Geology</b>	<p>Artificial Ground – No artificial ground recorded on site.          Superficial Deposits – None recorded.          Bedrock Geology – Brierley Rock - Sandstone.          Faults – Normal fault 213m south west.          Coal Outcrops – Brierley Coal (BY) recorded to be 0 to 1.3m thick outcropping 105m south west of the site. Younger rock (BrR) is shown on-site, indicating that Brierley Coal exists beneath the site.</p>
<b>Radon</b>	<p>&lt;1% of properties in the area are above the radon action level. Therefore, radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.</p>
<b>Ground workings</b>	<p>There are no ground workings shown within 250m of the site.</p>
<b>Mining</b>	<p>The site is within a Coal Mine Reporting Area therefore a Coal Report has been obtained from The Coal Authority.</p> <p>The Coal Authority confirm that the site is in the zone of influence of workings in 4N<sup>e</sup> seam of coal at 180m to 870m depth and last worked in 1954. Any movement from these workings should have stopped by now. The site is not affected by any present or planned underground mining however reserves of coal do exist in the area which may be worked at some time in the future.</p> <p>There is 1N<sup>e</sup> mine entry within 250m of the site. This is a disused mine shaft approximately 5m west of the site boundary. There are no records of what steps, if any, have been taken to treat the mine entry.</p> <p>The site is not affected by any past, present or future opencast mining.</p> <p>The Coal Authority have received 1N<sup>e</sup> claim for coal mine related subsidence for a property approximately 5m from the southern boundary of the site.</p> <p>The coal authority has no record of mine gas emissions requiring action.</p> <p>The property is in an area where a notice to withdraw support was given in 1983.</p> <p>There is a Development High Risk Area adjacent to the western boundary of the site, therefore a Coal Mining Risk Assessment has been carried out as part of this report and is presented in Section 4.</p>
<b>Natural Ground Subsidence</b>	<p>No natural ground subsidence problems are envisaged.</p>
<b>Boreholes</b>	<p>There are no BGS borehole records held for positions located within 250m of the site.</p>

### 2.3. Environmental Overview

<b>Historical Land Use</b>	The Groundsure report records 4№ potentially contaminative historical land uses shown within 250m of the site. The nearest is the smithy located 39m east from 1854.
<b>Current Land Use</b>	There are 4№ potentially contaminative current industrial land uses shown within 250m of the site. The nearest is a precision engineers 72m south east. Others include a haulage company (133m east), electrical engineers (151m west) and vehicle repair garage (193m south west).
<b>Environmental Permits</b>	There are no environmental permits shown within 250m of the site.
<b>Pollution Incidents</b>	There are no pollution incidents shown within 250m of the site.
<b>Landfill Sites</b>	There are no current or historical landfills shown within 250m of the site.
<b>Waste Transfer &amp; Processing Stations</b>	There are no waste transfer and processing stations shown within 250m of the site.
<b>Hydrogeology</b>	The bedrock is classed as a Secondary A Aquifer.  The site is not within a source protection zone.  There are no ground water abstractions within the vicinity of the site.
<b>Hydrology</b>	There are no watercourses or surface water abstractions shown within 250m of the site.
<b>Flooding</b>	The site is not within a flood risk area.
<b>Environmental Sensitivity</b>	The site is in a nitrate vulnerable zone.

### 2.4. Phase I Preliminary Recommendations

The Phase I report identified a number of potential pollution linkages that may be present within the site, and recommended that representative soil samples were removed from the site and submitted for contamination analysis.

It also recommended that a number of boreholes and/ or trial pits were undertaken in order to make comment on the foundation solution for the proposed development.

A preliminary coal mining risk assessment was undertaken which identified the risk from shallow depth coal mining works was moderate. As such rotary boreholes were recommended in order to investigate the shallow workings and identify any remedial works required.

### **3. Intrusive Investigation**

#### **3.1. Fieldwork**

The intrusive investigation consisted of 5№ window sampler boreholes and 2№ open hole rotary boreholes. The intrusive investigations were carried out on 14<sup>th</sup> June 2017; the locations of which can be found within Appendix I. 1№ window sampler borehole and 1№ open hole rotary borehole were carried out on the western boundary to confirm the adjacent shaft does not cross on to the site. 1№ rotary borehole was carried out in the south adjacent to an area of previously recorded coal mining related subsidence (off-site). The other boreholes were spread evenly across the site to give a good overview of the underlying strata. The weather was sunny and dry.

The boreholes found Made Ground to depths of between 0.45mbgl (BH05) and 0.8mbgl (BH04). The Made Ground consisted mainly of compact sandy gravels and soft sandy silty gravelly clay with brick, concrete rubble, coal fragments, sandstone gravels/ fragments, ash, pottery fragments and a slight organic odour in BH01 & 05. Tarmac was encountered in all the boreholes except for BH04. The Made Ground directly below the tarmac in BH01, 02 & 03 was sandy shaley brick. However BH05 did encounter a compact sandy limestone gravel sub-base.

Superficial deposits consisted mainly of stiff light orangish brown mottled silty CLAY with fine grained sandstone gravels were identified under most of the site, besides BH05, with typical thicknesses ranging between 0.475m (BH01) and 1.075m (BH04).

Bedrock was deepest in the centre (BH04) and towards the south eastern corner (BH03) of the site and was encountered at between 0.45mbgl (BH05) and 1.875mbgl (BH04). Bedrock comprised completely weathered light brown sandy MUDSTONE/SILTSTONE, occasionally becoming highly weathered and friable. Highly weathered light orangish brown fine grained SANDSTONE was found underlying the mudstone/ siltstone. These deposits are consistent with the Brierley Member which consists of mudstone, siltstone and sandstone and is part of the Pennine Upper Coal Measures Formation.

Logs of the window sample Boreholes and open hole rotary boreholes can be found in Appendix II and III of this report respectively.

Soil samples were removed for laboratory analysis from all of the window sampler boreholes.

#### **3.2. Groundwater**

Groundwater was not encountered during the site investigation.

#### **3.3. Gas Monitoring**

Gas and groundwater monitoring equipment was installed in 3№ borehole positions (BH01, BH03 and BH05). Response zones were set from 0.5mbgl to 1.9mbgl (BH01), 2.9mbgl (BH03) & 2mbgl (BH05) in order to evaluate the combined gas risk from both the Made Ground at the surface as well as natural venting from the aquifer.

Monitoring was undertaken using a Geotech GA5000 portable gas analyser which is calibrated on a 6 monthly basis. UKAS calibration certificates can be provided on request. Monitoring is currently ongoing. The results of this monitoring will be presented as an amendment to this report.

#### 3.4. **Laboratory Testing**

The desk study recommended a regime of contamination testing on soil samples recovered from the intrusive investigation. Samples were obtained during the site investigation and tested at a UKAS accredited laboratory for contaminants including:

*Heavy Metals*  
*Polycyclic Aromatic Hydrocarbons*  
*Total Petroleum Hydrocarbons*  
*Asbestos*

Geotechnical testing was also carried out on the soils. The samples were tested for:

*pH*  
*Water Soluble Sulphate (2:1)*  
*Atterberg limits*

## 4. Contamination Assessment

### 4.1. General

Current Environmental Legislation, in particular Part IIA of the Environmental Protection Act 1990, adopts a risk-based approach to the evaluation of contaminated sites, based on the proposed end use of the site. The commonly accepted approach is to adopt a Source-Pathway-Receptor model where the Source of the contaminant is examined in relation to potential Receptors (i.e. humans, controlled waters etc.) to determine if there is a Pathway (i.e. contaminant linkage) connecting them. If any of these elements (i.e. contaminant, pathway or receptor) are absent or removed, then there is no risk.

The Department of the Environment, Food and Rural Affairs (DEFRA) have published a series of guidelines in connection with Risk Assessment. In addition The Environment Agency has produced the Contaminated Land Exposure Model (CLEA) which models guideline values for those elements which pose the greatest risk to human health.<sup>1</sup> Using values derived from CLEA, a site specific, conceptual model has been used to determine any significant contaminant linkages and identify suitable risk management proposals on which remediation design (if any required) can be based. The conceptual model is summarised at the end of this section in tabular form.

By considering the Source-Pathway-Receptors Model, an assessment can be made as to whether the source contamination can reach a receptor. The degree and significance of any resulting risk is then determined. The categorisation of the risk is based on consideration of both:

- The likelihood or probability of an event (taking into account both the presence of the Source and the Receptor, and the integrity of the Pathway).
- The severity of the potential consequence (taking into account both the potential severity of the Source and the sensitivity of the Receptor).

The following categorisation of risk has been adopted in this report:

Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High	Harm is likely to arise to a designated receptor from an identified hazard without appropriate remedial action.
Moderate	It is possible that, without appropriate remedial action, harm could arise to a designated receptor, but it is relatively unlikely that any such harm would be severe and, if harm were to occur, it is more likely that such harm would be relatively mild.

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<sup>1</sup> Updated technical background to the CLEA model, Science Report SC050021/SR3, The Environment Agency, 2009

**Low** It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that, at worst, this harm, if realised, would normally be mild.

**Negligible** The presence of an identified hazard does not give rise to the potential to cause any significant harm to a designated receptor on this site.

#### 4.2. Preliminary Conceptual Site Model

The following table provides a list of the potential Sources, Pathways and Receptors that have potential to exist on this site as determined within the Phase I desk study.

Potential Source	Contaminants	Receptor	Pathway	Potential Risk
Soil based Contaminants (Solid)	Heavy Metals PAH TPH	Construction Workers Maintenance Workers End user	Direct contact with soil Ingestion of soils Inhalation of soil dust Inhalation of vapours (PAH/ TPH Only)	Moderate
		Off-site resident	Inhalation of soil dust Inhalation of vapours (PAH/ TPH Only)	Low
		Flora & Fauna	Plant Uptake	Low
		Buildings & Infrastructure	Direct Contact with soil	Low
Soil based Contaminants (as Leachate)	Heavy Metals PAH TPH	Flora & Fauna	Plant Uptake	Low
Asbestos within Made Ground	Asbestos Fibres	Construction Workers Maintenance Workers End user	Inhalation of asbestos fibres	Moderate/ High
Land Gas		Construction Workers Maintenance Workers End user	Inhalation of gases	Moderate

Based on the above conceptual site model, the following sources of contamination have been investigated;

- Soils
  - Heavy Metals
  - Poly Aromatic Hydrocarbons
  - Total Petroleum Hydrocarbons
  - Asbestos
- Land Gas

#### 4.3. Contamination Criteria for Soil Testing

Suitable 4 Use Levels (S4ULs) published by Land Quality Management, have been used to assess risk.<sup>2</sup> Where there are no S4ULs, Defra Category 4 Screening Levels (C4SLs) have been used as intervention values to assess risk.<sup>3</sup>

It is proposed that the site will be developed into residential buildings. Therefore the proposed land use can be classified as 'Residential' in accordance with the CLEA Guidelines.

Soils were taken from site and tested for % Soil Organic Matter (SOM).

Location	BH01	BH02	BH03	BH04	BH05
Depth (m)	0.4	0.5	0.5	0.3	0.4
Strata	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground
SOM (%)	2.9	14.7	5.2	5.7	4.3

Taking the lowest SOM recorded as the worst case scenario, the results of the chemical analysis on the soil samples are compared against the S4ULs for 'Residential with Home Produce' developments with 2.5% SOM (where there are published S4ULs) and C4SLs where there are no published S4ULs. These values are then used as Intervention Values (IV) to assess the risk.

#### 4.4. Results of Contamination Testing

The following tables are summaries of the laboratory test results. Please see the key below for the origin of each intervention value.

##### Intervention Value Key

Author	Type	Land Use
Land Quality Management	S4UL	Residential
DEFRA	C4SL	Residential

##### Heavy Metals

Location	BH01	BH02	BH03	BH04	BH05		
Depth (m)	0.4	0.5	0.5	0.3	0.4		
Strata	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground		
Contaminant (mg/kg)						IV	Number Exceeding
Arsenic	8	17	23	20	11	37	0
Cadmium	0.9	0.9	0.6	1	0.5	11	0
Copper	28	381	32	35	22	2400	0
Chromium	18	13	9	15	11	910	0
Lead	55	105	96	164	56	200	0
Mercury	<0.17	<0.17	<0.17	<0.17	<0.17	40	0
Nickel	20	29	21	22	16	130	0
Selenium	<1	<1	<1	<1	<1	250	0
Zinc	96	99	78	119	73	3700	0

<sup>2</sup> The LQM/CIEH S4ULs for Human Health Risk Assessment, Land Quality Press, Nathanail et. al, 2015.

<sup>3</sup> SP1010, Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, DEFRA 2014

### Polycyclic Aromatic Hydrocarbons

Location	BH01	BH02	BH03	BH04	BH05		
Depth (m)	0.4	0.5	0.5	0.3	0.4		
Strata	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground		
Contaminant (mg/kg)						IV	Number Exceeding
Acenaphthene	<0.01	<0.01	0.02	0.01	<0.01	510	0
Acenaphthylene	<0.01	<0.01	0.1	0.01	0.01	420	0
Anthracene	<0.02	0.04	0.37	0.08	0.05	5400	0
Benzo(a)anthracene	<0.04	0.35	3.03	0.46	0.31	11	0
Benzo(a)pyrene	<0.04	0.38	2.02	0.44	0.28	2.7	0
Benzo(b)fluoranthene	<0.05	0.48	2.41	0.52	0.33	3.3	0
Benzo(ghi)perylene	<0.05	0.3	0.79	0.27	0.14	340	0
Benzo(k)fluoranthene	<0.07	0.16	1	0.21	0.1	93	0
Chrysene	<0.06	0.38	2.52	0.5	0.3	22	0
Dibenzo(ah)anthracene	<0.04	0.07	0.28	0.08	0.04	0.28	1
Fluoranthene	<0.08	0.54	5.14	0.85	0.44	560	0
Fluorene	<0.01	<0.01	0.07	0.01	0.01	400	0
Indeno(123-cd)pyrene	0.05	0.33	1.12	0.32	0.18	36	0
Naphthalene	<0.03	0.04	<0.03	<0.03	<0.03	5.6	0
Phenanthrene	<0.03	0.18	1.16	0.34	0.17	220	0
Pyrene	<0.07	0.52	4.71	0.75	0.39	1200	0
Total PAH	<0.08	3.78	24.7	4.86	2.77		0

### Total Petroleum Hydrocarbons

Location	BH01	BH03	BH05		
Depth (m)	0.4	0.5	0.4		
Strata	Made Ground	Made Ground	Made Ground		
Contaminant (mg/kg)				IV	Number Exceeding
Ali >C5-C6	<0.01	<0.01	<0.01	78	0
Ali >C6-C8	<0.01	<0.01	<0.01	230	0
Ali >C8-C10	<0.01	<0.01	<0.01	65	0
Ali >C10-C12	<0.1	<0.1	<0.1	330	0
Ali >C12-C16	<0.1	<0.1	<0.1	2400	0
Ali >C16-C21	<0.1	<0.1	<0.1	92000	0
Ali >C21-C35	<0.1	<0.1	<0.1	92000	0
Total Aliphatics	<0.1	<0.1	<0.1	-	-
Aro >C5-C7	<0.01	<0.01	<0.01	140	0
Aro >C7-C8	<0.01	<0.01	<0.01	290	0
Aro >C8-C9	<0.01	<0.01	<0.01	83	0
Aro >C9-C10	<0.01	<0.01	<0.01	83	0
Aro >C10-C12	<0.1	<0.1	<0.1	180	0
Aro >C12-C16	<0.1	<0.1	<0.1	330	0
Aro >C16-C21	<0.1	2.6	0.5	540	0
Aro >C21-C35	<0.1	3.5	0.3	1500	0
Total Aromatics	<0.1	6	0.8	-	-
TPH (Ali & Aro)	<0.1	6	0.8	-	-
BTEX - Benzene	<0.01	<0.01	<0.01	0.17	0
BTEX - Toluene	<0.01	<0.01	<0.01	290	0
BTEX - Ethyl Benzene	<0.01	<0.01	<0.01	110	0
BTEX - m & p Xylene	<0.01	<0.01	<0.01	130	0
BTEX - o Xylene	<0.01	<0.01	<0.01	140	0
MTBE	<0.01	<0.01	<0.01	-	0

### Asbestos

Location	BH01	BH02	BH03	BH04	BH05	
Depth (m)	0.4	0.5	0.5	0.3	0.4	
Strata	Made Ground	Made Ground	Made Ground	Made Ground	Made Ground	
<b>Contaminant</b>						<b>Number Exceeding</b>
Asbestos in Soil	NAD	NAD	NAD	NAD	NAD	0

The full test certificates are included in Appendix IV of this report.

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#### 4.5. Radon and Land Gas

<1% of properties in the area are above the radon action level. Therefore radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.<sup>4</sup>

Gas and water monitoring equipment was installed in 3No positions across the site. Response zones were set from 0.5mbgl to 1.9mbgl (BH01), 2.9mbgl (BH03) & 2mbgl (BH05) so as to assess the risk from made ground towards the surface, as well as any natural venting from the aquifer below. The monitoring is currently ongoing and the results will be presented as an amendment to this report.

#### Results

Date	BH Number	CH <sub>4</sub> (%)	CO <sub>2</sub> (%)	O <sub>2</sub> (%)	Atmos. Pres.(mb)	Pres. Trend (24hrs)	Flow (l/h)	Water (mbgl)	Depth to Bottom (m)
22.06.17	BH01	0	4.8	17.3	998	↑	0.3	Dry	1.9
	BH03	0	1	20.2	998	↑	0.3	1.86	2.9
	BH05	0	4.1	17.5	998	↑	0.3	Dry	2

Date	BH Number	CH <sub>4</sub> (%)	CO <sub>2</sub> (%)	O <sub>2</sub> (%)	Atmos. Pres.(mb)	Pres. Trend (24hrs)	Flow (l/h)	Water (mbgl)	Depth to Bottom (m)
11.07.17	BH01	0	6.6	15.7	997	↓	0.3	1.86	1.9
	BH03	0	1	20.3	997	↓	0.3	1.94	2.9
	BH05	0	8.5	11.7	997	↓	0.3	Dry	2

<sup>4</sup> BRE 211, Radon: guidance on protective measures for new buildings, BREPress, Scivyer, 2007

## Analysis

Instead of monitoring on predetermined dates to a set schedule, it is best practice to gas monitor on occasions where the worst case scenario is likely to occur. Generally this is determined to be when sharp falls of atmospheric pressure occur or when low atmospheric pressures are recorded, (below 1000mb). Thus the remaining gas results will be collected in periods of high to low falling pressure as well as low pressure.

Two round of monitoring has been undertaken to date. Four further rounds of monitoring are proposed.

The gas monitoring results have been evaluated in conjunction with BS8485:2015<sup>5</sup> and the characteristic situations defined in CIRIA C665<sup>6</sup>.

The maximum concentrations of CH<sub>4</sub> and CO<sub>2</sub> recorded were 0 and 8.5% respectively. The maximum flow rate recorded across the site was 0.3l/h. Therefore the gas screening values (GSVs) for both methane and carbon dioxide are 0l/h and 0.0255l/h respectively.

In accordance with the BS8485:2015, due to the previous site usage and as the maximum CO<sub>2</sub> concentration is above 5% the site should be classified as characteristic situation 2.

In accordance with the BS8485:2015, the site is classed as characteristic situation 2 and the proposed future buildings on the site will be Type A, therefore, gas protection measures with a minimum gas protection score of 3.5 should be installed at the site. A vented sub-floor and gas proof membrane will typically be required to achieve this however alternative options may be available subject to the final form of the construction.

It should be noted that monitoring is still on-going and the above recommendations are to be considered as **PRELIMINARY**, to be confirmed on completion of the monitoring.

### 4.6. Contamination Sources

Elevated concentrations of land gas (CO<sub>2</sub>) exist on site. An elevated concentration of a Poly Aromatic Hydrocarbon (Dibenzo (ah) anthracene) also exists in one of the locations tested (BH03). The level identified is equal to the guidance criteria for a residential land use and therefore is not considered significantly elevated. The average value for Dibenzo (ah) anthracene on site is below the guidance criteria (0.1mg/kg) compared to a guidance value of 0.28mg/kg. None of the other PAHs tested exceeded the guidance values. It is considered that the contaminant originates from the Made Ground which is likely to be removed during the site strip carried out as part of the enabling works. Due to the contaminant concentrations and number of exceedances, no further works are considered necessary for the PAH identified.

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<sup>5</sup> Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (BS 8485:2015) BSI, 2015

<sup>6</sup> Assessing Risks Posed by Hazardous Ground Gases to Buildings (C665), CIRIA, Wilson et al., 2007

It is considered likely that the contaminant originates from the previous land uses.

Source	Elevated Levels Present?
Heavy Metals	No
Poly Aromatic Hydrocarbons	Yes (See Note Above)
Total Petroleum Hydrocarbons	No
Asbestos	No
Land Gas and Radon	Yes

#### 4.7. Pathways

Based on the proposed land use, the possible pathways that exist on site for any possible source of contamination are as follows;

Pathway	Pathway Present	Comments
a - Direct Contact with soil/ water	Yes	Potential for contact with soil/ water during future development works.
b - Incidental ingestion	Yes	Potential for ingestion of soils/ water during future development works.
c - Inhalation of soil dust/ asbestos fibres	Yes	Potential for inhalation of soil dust/ asbestos during future development works and ground disturbance.
d - Leaching/ migration of liquids	Yes	Limited potential for leaching currently as site is predominantly hardstanding. Potential for leaching increased in proposed soft landscaped areas.
e - Surface water run-off	No	Limited potential for surface water run-off as site will be developed with buildings and soft landscaping. No surface water features within 250m.
f - Migration/ emission/ accumulation/ inhalation of land gas/ vapours	Yes	Migration and emission of land gas/ vapours possible, however potential for accumulation in proposed buildings on site.
g - Plant uptake/ plant uptake followed by ingestion	Yes	Plant uptake in proposed soft landscaped areas.

#### 4.8. Receptors

Based on the identified sources of contamination, and the present pathways, the potential receptors for the development are:-

Receptor	Receptor Present	Comments
A - Site worker	Yes	Staff involved in construction and demolition works and underground utility works at the site.
B - Maintenance staff	Yes	Carrying out routine maintenance in the future (Assumes workers will visit the site on an infrequent basis and will not carry out intrusive works).
C - Long term site user/ future resident	Yes	Long term site users/ future residents.
D - Off-site resident	Yes	Residential housing adjacent to the site.
E - Flora & Fauna	Yes	Flora on landscaped areas
F - Aquifer	No	Bedrock is a Secondary A Aquifer, however there are no groundwater abstractions or source protection zones in the vicinity of the site
G - Surface water	No	No surface water features within 250m of the site.
H - Buildings & Infrastructure	Yes	Water supply pipes.

#### 4.9. Site Specific Model

Source	Contaminant	Receptor	Pathway	Risk
Soil based contaminants (Solid)	<i>Heavy Metals</i> <sup>2</sup>	A – Site Worker <sup>1</sup> B – Maintenance Staff <sup>1</sup> C – Long Term Site user/Future End user <sup>1</sup> D – Off-Site Resident <sup>1</sup> E – Flora & Fauna <sup>1</sup> H – Buildings & Infrastructure	a – Direct contact with soil/ water <sup>1</sup> b – Incidental ingestion <sup>1</sup> c – Inhalation of soil dust/ asbestos fibres <sup>1</sup> g – Plant uptake/ plant uptake followed by ingestion <sup>1</sup>	Negligible
	<b>Polycyclic Aromatic Hydrocarbons</b> <sup>1</sup>	A – Site Worker <sup>1</sup> B – Maintenance Staff <sup>1</sup> C – Long Term Site user/Future End user <sup>1</sup> D – Off-Site Resident <sup>1</sup> E – Flora & Fauna <sup>1</sup> H – Buildings & Infrastructure	a – Direct contact with soil/ water <sup>1</sup> b – Incidental ingestion <sup>1</sup> c – Inhalation of soil dust/ asbestos fibres <sup>1</sup> g – Plant uptake/ plant uptake followed by ingestion <sup>1</sup>	Very Low
	<i>Total Petroleum Hydrocarbon</i> <sup>2</sup>	A – Site Worker <sup>1</sup> B – Maintenance Staff <sup>1</sup> C – Long Term Site user/Future End user <sup>1</sup> D – Off-Site Resident <sup>1</sup> E – Flora & Fauna <sup>1</sup> H – Buildings & Infrastructure	a – Direct contact with soil/ water <sup>1</sup> b – Incidental ingestion <sup>1</sup> c – Inhalation of soil dust/ asbestos fibres <sup>1</sup> g – Plant uptake/ plant uptake followed by ingestion <sup>1</sup>	Negligible
Asbestos in Made Ground	<i>Asbestos fibres</i> <sup>2</sup>	A – Site Worker <sup>1</sup>	c – Inhalation of soil dust/ asbestos fibres <sup>1</sup>	Negligible
<b>Land Gas</b> <sup>1</sup>		A – Site Worker <sup>1</sup> B – Maintenance Staff <sup>1</sup> C – Long Term Site user/Future End user <sup>1</sup> D – Off-Site Resident <sup>1</sup>	f – Migration/ emission/ accumulation/ inhalation of land gas/ vapours <sup>1</sup>	Moderate
<i>Radon</i> <sup>2</sup>		A – Site Worker <sup>1</sup> B – Maintenance Staff <sup>1</sup> C – Long Term Site user/Future End user <sup>1</sup> D – Off-Site Resident <sup>1</sup>	f – Migration/ emission/ accumulation/ inhalation of land gas/ vapours <sup>1</sup>	Negligible

1- Source/ Pathway/ Receptor PRESENT on site

2- Source/ Pathway/ Receptor NOT PRESENT on site

#### 4.10. Contamination Issues

Based upon the conceptual site model, there are 10№ contamination linkages present for the sources tested for.

1. PAH with respect to Site Workers
2. PAH with respect to Maintenance Staff
3. PAH with respect to Long Term Site User/ Future End User
4. PAH with respect to the Off-Site Resident
5. PAH with respect to Flora & Fauna
6. PAH with respect to Building & Infrastructure

Due to the PAHs concentrations and number of exceedance identified, it is considered these present a very low risk to the potential receptors and therefore no further works are considered necessary.

However the elevated levels of land gas (CO<sub>2</sub>) are considered a moderate risk to the potential receptors listed below.

1. Land Gas (CO<sub>2</sub>) with respect to Site Worker.
2. Land Gas (CO<sub>2</sub>) with respect to Maintenance Staff.
3. Land Gas (CO<sub>2</sub>) with respect to Long Term Site User/ Future End User.
4. Land Gas (CO<sub>2</sub>) with respect to Off-Site Residents.

#### 4.11. Assessed Risks and Management

Slightly elevated concentrations of Dibenzo (ah) anthracene are present in one of the locations tested on site. Elevated levels of CO<sub>2</sub> also exist on site.

A site induction should warn construction workers as to the presence of contaminated material onsite. Appropriate personal protective equipment should be worn, accompanied with employing good personal hygiene standards (especially before eating) in order to minimise the risk to construction workers on site.

Any tarmac should be removed from soft landscaped areas.

The contaminants identified are deemed to exist within the Made Ground at the surface of the site. It is assumed the Made Ground will be removed from site as part of the enabling works and adequate clean & certified topsoil will be added to all soft landscaping areas to act as a suitable growing medium. It is considered that this will act a suitable barrier to any possible contaminants.

The following table details the assessed risk from the Site-Specific conceptual site model, the recommended Management/Remediation proposals and the Residual Risk after these proposals have been implemented.

Source	Pathway	Receptor	Risk	Management / Remediation Proposals	Residual Risk
<b>PAH</b>	a, b, c	<b>A</b>	<b>Very Low</b>	Site induction to cover the potential for contaminants existing on site. Personal Protective Equipment to be used at all times including gloves. Good levels of Personal hygiene to be maintained including washing hands before eating.	<b>Negligible</b>
<b>Land Gas (CO<sub>2</sub>)</b>	f	<b>A, B, C, D</b>	<b>Moderate</b>	Gas protection measures with a minimum gas protection score of 3.5 points should be installed at the site in accordance with BS8485:2015.	<b>Negligible</b>

All ground works should be monitored by a suitably qualified person and significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further works.

#### 4.12. **Environmental Summary**

Slightly elevated concentrations of Dibenzo (ah) anthracene are present in one of the locations tested on site. Elevated levels of CO<sub>2</sub> also exist on site.

A site induction and appropriate PPE should mitigate any risk towards construction workers.

A remediation statement will be required to accompany any planning application detailing the risks identified and the mitigation measures prescribed.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further works.

## 5. Geotechnical Assessment

### 5.1. General

The site investigation was required to make recommendations as to a suitable foundation solution for the development. 5N<sup>o</sup> window sampler boreholes and 2N<sup>o</sup> open hole rotary boreholes were undertaken to maximum depths of 3.17mbgl and 30mbgl respectively in order to achieve this aim.

### 5.2. Geological Assessment

#### Artificial Deposits

The boreholes found Made Ground to depths of between 0.45mbgl (BH05) and 0.8mbgl (BH04). The Made Ground consisted mainly of compact sandy gravels and soft sandy silty gravelly clay with brick, concrete rubble, coal fragments, sandstone gravels/ fragments, ash, pottery fragments and a slight organic odour in BH01 & 05. Tarmac covered the site and a sub-base was only noted on BH05

#### Superficial Deposits

Superficial deposits consisted mainly of stiff light orangish brown mottled silty CLAY with fine grained sandstone gravels were identified under most of the site, besides BH05, with typical thicknesses ranging between 0.475m (BH01) and 1.075m (BH04).

#### Bedrock

Bedrock was deepest in the centre (BH04) and towards the south eastern corner (BH03) of the site and was encountered at depths between 0.45mbgl (BH05) and 1.875mbgl (BH04). Bedrock comprised completely weathered light brown sandy MUDSTONE/SILTSTONE, occasionally becoming highly weathered and friable. Highly weathered light orangish brown fine grained SANDSTONE was found underlying the mudstone/ siltstone.

### 5.3. Mining

Based on the findings from the open hole rotary boreholes, possible collapsed workings were found within both boreholes. Possible collapsed workings were encountered at 18.4mbgl and 19.2mbgl with thicknesses of 1.5m and 1.1m respectively.

	RH01	RH02
Depth to Rock (m)	1.4	1.6
Rock Cover (m)	17	17.7
Possible Collapsed Workings Thickness (m)	1.5	1.1
Rock Cover to Void/Collapsed Workings Ratio	11.3:1	16.1:1

The current best practise requires that rock cover to void ratio of 10:1 is required to mitigate the risk from crown hole migration. The ratios for the site range from 11.3:1 to 16.1:1 showing that the risk from migration is low and no further mitigation is required.

Given no accurate data for the offsite mine shaft and no positive ID on site we must assume the shaft may be located immediately beyond the boundary. Therefore we suggest a 'no build' zone is incorporated into the development plan to allow for a possible shaft collapse. Based on depth of bedrock along the boundary a 'no build' zone of 3.1m from the site boundary should be assumed.

#### 5.4. Foundations and substructures

Based on the geological conditions found below the site, shallow depth spread foundations are generally suitable for the proposed development. The foundations should be taken to the stiff clay at a minimum depth of 1mbgl. An allowable bearing pressure of 100kN/m<sup>2</sup> should be assumed. The unit adjacent to the proposed 'no build' zone should be founded on rock as an added precaution with trench filled foundations in areas where tree influence dictates the depth of the foundations, deeper trench fill foundations may be required. The bearing of all foundations should be consistent and be founded on the same strata. Nominal B785 reinforcement mesh should be placed within the centre of the foundations as a precaution.

#### 5.5. Geotechnical Test Results

Soil samples were taken from site and submitted for the following geotechnical testing.

Location	BH01	BH03	BH05
Depth to Top (m)	0.8	1	1.1
Depth to Bottom (m)	1.2	1.3	1.4
Strata	Natural	Natural	Natural
pH	5.03	6.61	5.36
SO <sub>4</sub> (2:1)	0.03	0.02	0.03
Plasticity Index	18	19	21
% <425µm	100	100	95
Modified Plasticity	18	19	21

Based on the soil sulphate concentrations and pH levels, AC-1s conditions exist for buried concrete in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.<sup>7</sup>

The Plasticity Index for the soils tested, have been modified as per chapter 4.2 of NHBC guidelines. The results show medium volume change soils exist on site. As trees already exist towards the north and south of the site, foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.<sup>8</sup>

#### 5.6. Ground Floor Construction

Suspended ground floors are preferable for the ground floor of the development.

<sup>7</sup> BRE Special Digest 1, Concrete in Aggressive Ground, BRE Press, 2005

<sup>8</sup> NHBC Standards, Chapter 4.2 Building Near Trees, NHBC, 2014

## 5.7. Geotechnical Summary

Shallow depth spread foundations are deemed suitable for the development. However the tree influence may dictate that foundations are taken to be rock depth, requiring deep trench fill foundations to be adopted. Bearing needs to be consistent and on the same strata for all foundations for the same unit.

The shallow spread foundations should be founded onto the stiff clay found under the site dependent on levels.

A 'no build' zone of 3.1m from the site boundary should be assumed to mitigate against possible mine shaft collapse. Foundations for the unit adjacent to this should also be taken to rock as a precaution.

Suspended ground floors are preferable for the proposed buildings.

Based on the soluble sulphate levels found, AC-1s conditions exist on site in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.

Medium volume change soils exist below the site. Foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further

## 6. Conclusions and Recommendations

In conclusion:

- 4No contamination linkages of concern are deemed exist on the site due to elevated CO<sub>2</sub> levels. Additional contamination linkages exist for slightly elevated concentrations of Dibenzo (ah) anthracene found in one location on site, however it is considered these present a very low risk to the potential receptors and therefore no further works are considered necessary
- Based on preliminary gas monitoring results, gas protection measures are required for the proposed development in accordance with BS8485:2015
- The site is underlain by of Made Ground above various strata of the Brierley Member which consists of mudstone, siltstone and sandstone and is part of the Pennine Upper Coal Measures Formation.
- Shallow depth spread foundations are deemed suitable for the proposed development.

Based on these findings, we recommend that the following should be undertaken:

- A remediation statement will need to be prepared to accompany any planning application, detailing all remedial measures for the site as well as detailed guidance on the verification of the measures employed

# Appendix I

## Site Investigation Plan



## **Appendix II**

### Windowless Sampler Logs



Cloverdale  
Haugh Head  
Wooler  
NE71 6QS

CLIENT MET ENGINEERS  
LOCATION THREE HORSE SHOE BRIDGES  
JOB No. 13187-5001  
BOREHOLE No. 01  
RIG TYPE DRT  
DATE WEDS 14th JUNE 2017  
OPERATOR S. WOOD

### DAILY RECORD SHEET

STRATA DISCIPTION		START DEPTH	STRATA BASE (m)	TESTING: SPT(s) CPT(c) U100(u) VANE TEST(v)							
Type No.	m		U Blows	0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	V Reading	
	From	To									
			G.L.								
S	1.00	1.45	0.050	1	2	3	3	3	4		
S	1.90	2.015	0.360	15	10	(115mm)					
S	2.015	2.160	0.775	23	27	(145mm)					
SAMPLES:-- BULK (B) DISTURBED (D)											
Type No.	m		Sampler Used (mm)	Recovery (mm)							
	From	To									
D	0.40										
J	0.40										
V	0.40										
B	0.80	1.20									
			Borehole Complete / Incomplete	2.160							
CASING											
Size (mm)		From		To							
115		G.L.		1.00							
INSTALLATION											
Type	Size	Depth (m)	Seal Top (m)	Seal Bottom (m)							
Gas/Water	63mm	1.90	0.50-0.10								
CORING											
Ground		From (m)		To (m)							
WATER											
Observation	Depth	Sealed	In Flow	Casing							
DRY				1.00							
REMARKS											
ARISING DISPOSAL ON SITE											

SIGNED DRILLER

CLIENT



Cloverdale  
Haugh Head  
Wooler  
NE71 6QS

CLIENT **MET ENGINEERS**  
LOCATION **THREE HORSE SHOES BRIDGEMAN**  
JOB No. **138157-5001**  
BOREHOLE No. **02**  
RIG TYPE **DSLT**  
DATE **WEDNESDAY 14<sup>TH</sup> JUNE 2017**  
OPERATOR **S. WOOD**

**DAILY RECORD SHEET**

STRATA DISCIPTION	START DEPTH	STRATA BASE (m)		
		G.L.		
TADMAL	0.090			
COMPACT DARK BROWN SANDY SHALE & BRICK RUBBLE - MADE GROUND	0.265			
COMPACT RUDDY/DARK BROWN SANDY GRAVELS BRICK RUBBLE, BRICK, COAL FRAGMENTS - MADE GROUND	0.750			
STIFF LIGHT GREY/ORANGE BROWN MOTTLED SILTCLAY, SOME SANDSTONE GRAVELS / FRAGMENTS	1.400			
COMPLETELY WEATHERED LIGHT BROWN / BROWN SANDY MUDSTONE / SILTSTONE	2.375			
HIGHT WEATHERED LIGHT BROWN / YELLOW BROWN FINE SANDSTONE				
Borehole Complete / Incomplete		2.790		
<b>CASING</b>				
Size (mm)	From	To		
115	G.L.	1.00		
<b>INSTALLATION</b>				
Type	Size	Depth (m)	Seal Top (m)	Seal Bottom (m)
<b>CORING</b>				
Ground	From (m)	To (m)		

TESTING: SPT(s) CPT(c) U100(u) VANE TEST(v)										
Type No.	m		U Blows	0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	V Reading
	From	To								
S	1.00	1.45		2	2	3	3	3	3	
S	2.00	2.45		4	4	3	4	9	8	
S	2.50	2.60		1015		(150mm)				
S	2.650	2.790		2426		(140mm)				

SAMPLES:- BULK (B) DISTURBED (D)				
Type No.	m		Sampler Used (mm)	Recovery (mm)
	From	To		
D	0.50			
J	0.50			

WATER				
Observation	Depth	Sealed	In Flow	Casing
DRY				1.00

**REMARKS**  
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SIGNED  
DRILLER

CLIENT



Cloverdale  
Haugh Head  
Wooler  
NE71 6QS

CLIENT MET ENGINEERS  
LOCATION THREE HORSE SHOES BRIBRIUM  
JOB No. 13187-5001  
BOREHOLE No. 03  
RIG TYPE DRIT  
DATE WEDS 14<sup>TH</sup> JUNE 2017  
OPERATOR S. WOOD

**DAILY RECORD SHEET**

STRATA DESCRIPTION	START DEPTH	STRATA BASE (m)
TARMAC		G.L.
COMPACT BRICK CONCRETE RUBBLE MOUND GROUND	0.030	
COMPACT BROWN MELLOW BROWN SANDS SANDSTONE FRAGMENTS. SOME BRICK, COAL FRAGMENTS. DRAIN FROM 0.50 TO BASE. MOUND GROUND.	0.160	
FIRM ORANGE BROWN/LIGHT BROWN SILT CLAY, WITH SOME FINE SANDSTONE GRAVELS / FRAGMENTS SANDSTONE GABBLE 0.850-1.00	0.700	
STIFF LIGHT BROWN/LIGHT BROWN MOTTLED SILTY CLAY SOME FINE SANDSTONE GRAVELS / FRAGMENTS.	1.00	
COMPACT / LIGHT WEATHERED, BROWN / LIGHT BROWN / ORANGE BROWN SANDS FRIABLE MUDSTONE / SILTSTONE	1.750	
Borehole Complete / Incomplete		3.170

TESTING: SPT(s) CPT(c) U100(u) VANE TEST(v)										
Type No.	m		U Blows	0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	V Reading
S	1.00	1.45		3	3	3	2	2	3	
S	2.00	2.45		3	3	7	8	9		
S	2.90	3.04		10	15	(145mm)				
S	3.04	3.17		26	24	(125mm)				

SAMPLES:-- BULK (B) DISTURBED (D)				
Type No.	m		Sampler Used (mm)	Recovery (mm)
D	0.50			
J	0.50			
V	0.50			
B	1.00	1.30		


CASING		
Size (mm)	From	To
115	G.L.	1.00

INSTALLATION				
Type	Size	Depth (m)	Seal Top (m)	Seal Bottom (m)
Gas/Water	63mm	2.900	0500-0100	

CORING		
Ground	From (m)	To (m)

WATER				
Observation	Depth	Sealed	In Flow	Casing
DRY				1.00

**REMARKS**  
ARISINGS DISPOSED ON SITE.

SIGNER   
DRILLER CLIENT



Cloverdale  
Haugh Head  
Wooler  
NE71 6QS

CLIENT MET ENGINEERS  
LOCATION THREE HORSE SHED BRIBBLEY  
JOB No. 13187-5001  
BOREHOLE No. 04  
RIG TYPE DSRT  
DATE WEDS 14TH JUNE 2017  
OPERATOR S. WOOD

**DAILY RECORD SHEET**

STRATA DISCUSSION	START DEPTH	STRATA BASE (m)		
GRASS OVERLAPPING DARK BROWN SANDY GRAVELS OCCASIONAL FIRM CLUSTERY BANDS, BRICK ROCK, ASD, POTTERY FRAGMENTS. MOIST GROUND.	0.700	G.L.		
COMPOSITE YELLOW BROWN/BROWN SANDY SOME SANDSTONE GRAVELS <u>DISTURBED</u>	0.800			
COMPOSITE BROWN SILT SAND SOME FINE/ MEDIUM SANDSTONE GRAVELS.	1.00			
STIFF LIGHT BROWN/LIGHT BILET ORANGE BROWN MORTUON SILT CLAY SOME FINE SANDSTONE GRAVELS/FRAGMENTS.	1.875			
COMPLETELY HIGHLY WEATHERED LIGHT BROWN/ BROWN SANDY FRIABLE MUDSTONE.	2.700			
HIGHLY WEATHERED LIGHT BROWN/ORANGE BROWN FINE SANDSTONE.				
Borehole Complete / Incomplete		2.940		
<b>CASING</b>				
Size (mm)	From	To		
115	G.L.	1.00		
<b>INSTALLATION</b>				
Type	Size	Depth (m)	Seal Top (m)	Seal Bottom (m)
<b>CORING</b>				
Ground	From (m)	To (m)		

TESTING: SPT(s) CPT(c) U100(u) VANE TEST(v)										
Type No.	m		U Blows	0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	V Reading
S	1.00	1.45		2	1	2	2	3	3	
S	2.00	2.45		5	7	8	8	7	10	
S	2.75	2.825		25 (75mm)						
S	2.825	2.940		30 20 (115mm)						

SAMPLES:- BULK (B) DISTURBED (D)				
Type No.	m		Sampler Used (mm)	Recovery (mm)
D	0.30			
J	0.30			

WATER				
Observation	Depth	Sealed	In Flow	Casing
DRY				1.00

**REMARKS**  
BIBBICKILLED WITH BRISINGS.

SIGNED  DRILLER  
CLIENT



Cloverdale  
Haugh Head  
Wooler  
NE71 6QS

CLIENT: MET ENGINEERS  
LOCATION: THREE HORSE SHOES BRILLIANT  
JOB No: 13187-5001  
BOREHOLE No: OS  
RIG TYPE: DART  
DATE: WEDS 14TH JUNE 2017  
OPERATOR: S. WOOD

**DAILY RECORD SHEET**

STRATA DESCRIPTION	START DEPTH	STRATA BASE (m)		
		G.L.		
TORRONS	0.190			
COMPACT LIGHT BROWN SANDY LIMESTONE GRAVELS - SUB-BASE	0.285			
COMPACT DARK BROWN/GREENY BROWN SANDY SILT GRAVEL CLAY. LOCAL PROLUMINIS. SLIGHT ORGANIC ODOUR INSIDE GROUND.	0.450			
COMPACT LIGHT BROWN/YELLOW BROWN FINE TO MEDIUM SAND WITH FINE/MEDIUM SANDSTONE GRAVELS/PROLUMINIS. POSSIBLE COMPLETELY WEATHERED SANDSTONE RECOVERED AS SAND AND GRAVELS.	1.100			
STIFF LIGHT BROWN/LIGHT GREY FINE TO SILT CLAY POSSIBLE COMPLETELY WEATHERED MUDSTONE.	1.700			
HIGHLY WEATHERED LIGHT BROWN/BROWN/ORANGE BROWN FINE SANDY MUDSTONE/SILTSTONE.				
Borehole Complete / Incomplete		2.420		
<b>CASING</b>				
Size (mm)	From	To		
115	G.L.	1.00		
<b>INSTALLATION</b>				
Type	Size	Depth (m)	Seal Top (m)	Seal Bottom (m)
EAS/WATER	63mm	2.00	0.50-0.100	
<b>CORING</b>				
Ground	From (m)	To (m)		

SIGNED  
DRILLER

CLIENT

TESTING: SPT(s) CPT(c) U100(u) VANE TEST(v)										
Type No.	m		y Blows	0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	V Reading
	From	To								
S	1.00	1.45		2	2	2	2	3	3	
S	2.00	2.420		5	8	13	15	15	7	(420mm)
S										50 (270mm)

SAMPLES: - BULK (B) DISTURBED (D)				
Type No.	m		Sampler Used (mm)	Recovery (mm)
	From	To		
D	0.40			
J	0.40			
V	0.40			
B	1.10	1.40		

WATER				
Observation	Depth	Sealed	In Flow	Casing
DRY				1.00

**REMARKS**  
ARISINGS DISPOSED ON SITE

## **Appendix III**

### Open Hole Rotary Borehole Logs

# GEOINVESTIGATE Ltd.



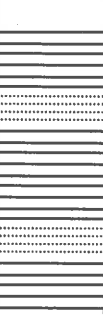
Your Ref. 13187/5001

Our Ref. G17218

RH No.1 Sheet No. 1 of 2










Location: Three Horse Shoes, Brierley S72 9JT

DATE: 14/06/17

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
1.40	Light brown DRIFT	1400							
4.30	Orange SILTSTONE, SANDSTONE inclusions	2900					Lost flush at 3.70m		2.50
6.40	MUDSTONE	2100					Flush returned at 6.60m		5.00
18.4	Light grey MUDSTONE with occasional SANDSTONE inclusions	12000					Flush lost at 11.20m		7.50 10.00 12.50 15.00 17.50
19.9	Possible COLLAPSED WORKINGS	1500							20.00
	MUDSTONE with occasional SANDSTONE inclusions	10100							22.50
	Rotary hole continued on page 2								25.00

**Remarks:** Casing to 1.00m  
 Microdrill rotary open hole borehole to 30.00m  
 No cores recovered from borehole  
 No gas detected from borehole on completion  
 Lost flush at 11.20m. No voids encountered.

**Key:**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li> Slotted Pipe</li> <li> Plain Pipe</li> <li> Bentonite</li> <li> Gravel Filter</li> </ul> | <ul style="list-style-type: none"> <li> Disturbed sample</li> <li> Shear vane</li> <li> Water sample</li> <li> Standard Penetration Test</li> <li> Cone Penetration Test</li> </ul> |
|--|--|

RH1

# GEOINVESTIGATE Ltd.

Your Ref. 13187/5001

Our Ref. G17218

RH No.1 Sheet No. 2 of 2

Location: Three Horse Shoes, Brierley S72 9JT

DATE: 14/06/17

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
30.0	MUDSTONE with occasional SANDSTONE inclusions	10100							27.50
	Rotary hole terminated at 30.00m								30.00

**Remarks:** Casing to 1.00m  
 Microdrill rotary open hole borehole to 30.00m  
 No cores recovered from borehole  
 No gas detected from borehole on completion  
 Flush lost at 11.20m. No voids encountered.

**Key:**

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li> Slotted Pipe</li> <li> Plain Pipe</li> <li> Bentonite</li> <li> Gravel Filter</li> </ul> | <ul style="list-style-type: none"> <li> Disturbed sample</li> <li> Shear vane</li> <li> Water sample</li> <li> Standard Penetration Test</li> <li> Cone Penetration Test</li> </ul> |
|--|---|

RH1

# GEOINVESTIGATE Ltd.




Your Ref. 13187/5001

Our Ref. G17218

RH No.2 Sheet No. 1 of 2










Location: Three Horse Shoes, Brierley S72 9JT

DATE: 14/06/17

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type Result	Flush	Depth to Water	Depth (m)
1.60	Dark brown DRIFT	1600							
6.80	Orange SILTSTONE with occasional SANDSTONE inclusions	5200							2.50
								Lost return at 5.40m	5.00
19.3	MUDSTONE with occasional SANDSTONE inclusions	12500							7.50
									10.00
									12.50
									15.00
									17.50
20.4	Possible COLLAPSED WORKINGS	1100							20.00
	MUDSTONE with occasional SANDSTONE inclusions	9600							22.50
	Rotary hole continued on page 2								25.00

**Remarks:** Casing to 1.00m  
 Microdrill rotary open hole borehole to 30.00m  
 No cores recovered from borehole  
 No gas detected from borehole on completion  
 Lost flush at 5.40m. No voids encountered.

**Key:**

- |   |               |   |                           |
|---|---------------|---|---------------------------|
|  | Slotted Pipe  |  | Disturbed sample          |
|  | Plain Pipe    |  | Shear vane                |
|  | Bentonite     |  | Water sample              |
|  | Gravel Filter |  | Standard Penetration Test |
|   |               |  | Cone Penetration Test     |

RH2

# GEOINVESTIGATE Ltd.

Your Ref. 13187/5001

Our Ref. G17218

RH No.2 Sheet No. 2 of 2

Location: Three Horse Shoes, Brierley S72 9JT

DATE: 14/06/17

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well	Sample	Test Type	Result	Flush	Depth to Water	Depth (m)
30.0	MUDSTONE with occasional SANDSTONE inclusions	9600								27.50
	Rotary hole terminated at 30.00m									30.00

**Remarks:** Casing to 1.00m  
 Microdrill rotary open hole borehole to 30.00m  
 No cores recovered from borehole  
 No gas detected from borehole on completion  
 Flush lost at 5.40m. No voids encountered.

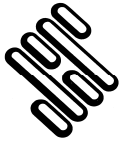
**Key:**

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li> Slotted Pipe</li> <li> Plain Pipe</li> <li> Bentonite</li> <li> Gravel Filter</li> </ul> | <ul style="list-style-type: none"> <li> Disturbed sample</li> <li> Shear vane</li> <li> Water sample</li> <li> Standard Penetration Test</li> <li> Cone Penetration Test</li> </ul> |
|--|---|

RH2

## **Appendix IV**

### Soil Test Results



# STRUCTURAL SOILS LTD

## TEST REPORT



Report No. 782654 R1

Date 29-June-2017 Contract 17/04115

Client Envirolab Ltd  
Address Units 7 & 8 Sandpits Business Park  
Mottram Road  
Hyde  
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client	19/06/2017	Client Reference	17/04115
Testing Started	21/06/2017	Client Order No.	P0736136
Testing Completed	29/06/2017	Instruction Type	Written

### UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2 (superseded)\*\*  
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3  
Plastic Limit BS1377:Part 2:1990,clause 5.3  
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

\* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

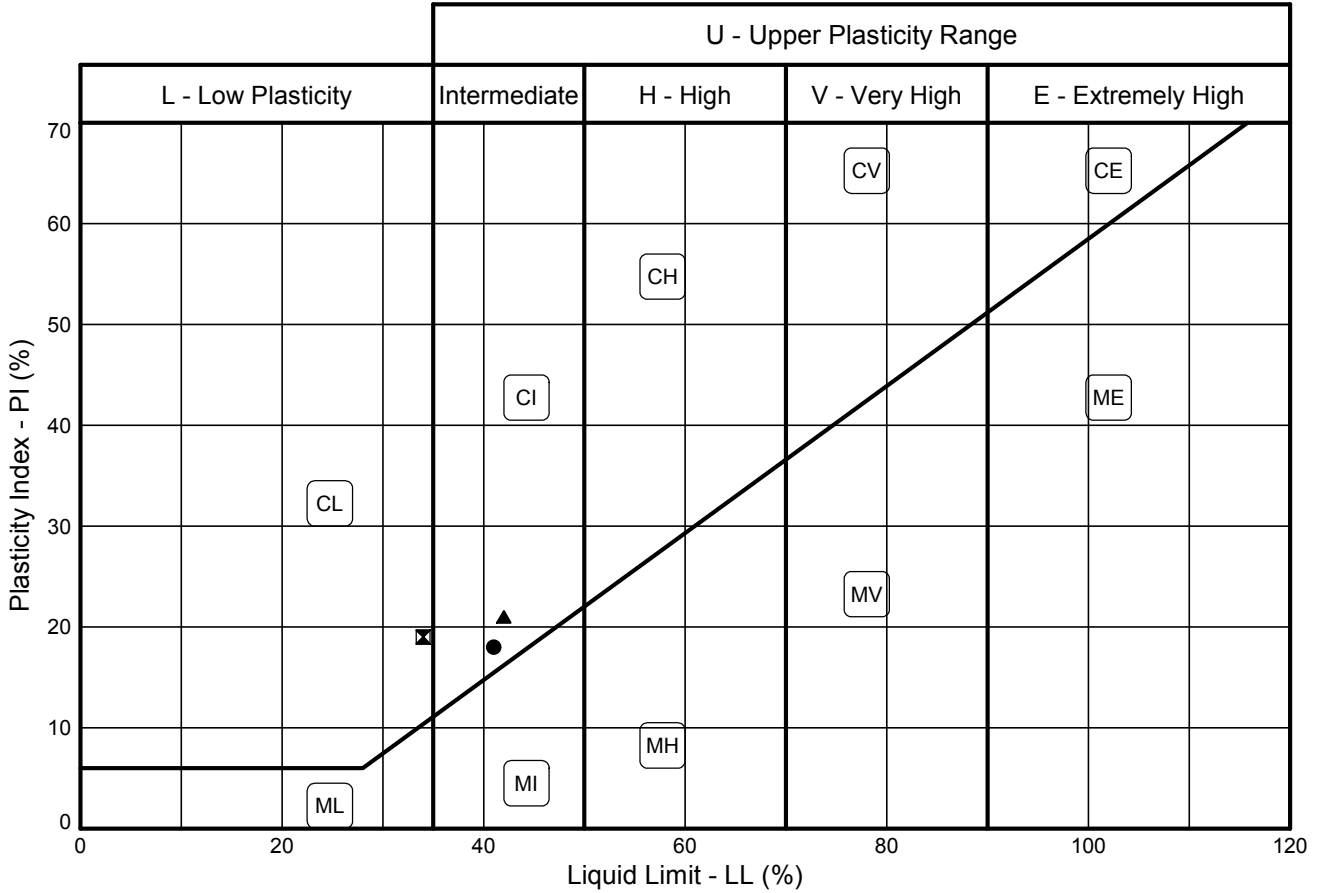
Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.  
Test were undertaken on samples 'as received' unless otherwise stated.  
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail mark.athorne@soils.co.uk



# PLASTICITY CHART - PI Vs LL

In accordance with clause 42.3 of BS5930:1999  
Testing in accordance with BS1377-2:1990

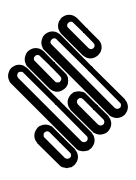


Sample Identification			BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %	Lab location	
Exploratory Position ID	Sample	Depth (m)									
●	BH01	17/04115/2D	0.80	3.2/4.3/5.3/5.4	4.2.3	22	41	23	18	100	C
⊠	BH03	17/04115/5D	1.00	3.2/4.3/5.3/5.4	4.2.3	18	34	15	19	100	C
▲	BH05	17/04115/8D	1.10	3.2/4.3/5.3/5.4	4.2.4	21	42	21	21	95	C

# Tested in accordance with the following clauses of BS1377-2:1990.  
3.2 - Moisture Content  
4.3 - Cone Penetrometer Method  
4.4 - One Point Cone Penetrometer Method  
4.6 - One Point Casagrande Method  
5.3 - Plastic Limit Method  
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.  
4.2.3 - Natural State  
4.2.4 - Wet Sieved  
Key: \* = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)



**STRUCTURAL SOILS**  
The Potteries  
Pottery Street  
Castleford  
W. Yorkshire WF10 1NJ

Compiled By		Date
<i>M. Athorne</i>		30/06/17
Contract		Contract Ref:
17/04115		782654



GINT\_LIBRARY\_v8\_06\_GLB LibVersion: v8\_06\_017 ProjVersion: v8\_06\_06 - Core+Geotech Lab-Castleford - 007 | Graph L - ALINE STANDARD - A4P | 782654 - 17-04115.GPJ - v8\_06 - Structural Soils Ltd, Branch Office - Castleford: The Potteries, Pottery Street, Castleford, West Yorkshire, WF10 1NJ, Tel: 01977-552255, Fax: 01977-552299, Web: www.structuralsols.co.uk, Email: ask@structuralsols.co.uk | 30/06/17 - 09:26 | MAA11

# TESTING VERIFICATION CERTIFICATE



1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **30/06/2017 09:27:16**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory  
**Mark Athorne (Laboratory Manager)**

(Head Office)  
Bristol Laboratory  
Unit 1A, Princess Street  
Bedminster  
Bristol  
BS3 4AG

Castleford Laboratory  
The Potteries, Pottery Street  
Castleford  
West Yorkshire  
WF10 1NJ

Hemel Laboratory  
18 Frogmore Road  
Hemel Hempstead  
Hertfordshire  
HP3 9RT

Tonbridge Laboratory  
Anerley Court, Half Moon Lane  
Hildenborough  
Tonbridge  
TN11 9HU



**STRUCTURAL  
SOILS LTD**

Contract:

**17/04115**

Job No:

**782654**



## FINAL ANALYTICAL TEST REPORT

**Envirolab Job Number:** 17/04115  
**Issue Number:** 1  
**Date:** 03 July, 2017

**Client:** MET Engineers Ltd  
Southgate House  
Pontefract Road  
Leeds  
LS10 1SW

**Project Manager:** Joseph Morley  
**Project Name:** Land Adj to Three Horse Shoes, Brierley  
**Project Ref:** 13187-5001  
**Order No:** 245-2017-JAM  
**Date Samples Received:** 16/06/17  
**Date Instructions Received:** 16/06/17  
**Date Analysis Completed:** 30/06/17

**Prepared by:**



Kate Keningale  
Sales Executive

**Approved by:**



Iain Haslock  
Analytical Consultant

Envirolab Job Number: 17/04115

Client Project Name: Land Adj to Three Horse Shoes, Brierley

Client Project Ref: 13187-5001

Lab Sample ID	17/04115/1	17/04115/2	17/04115/3	17/04115/4	17/04115/5	17/04115/6	17/04115/7	17/04115/8	Units	Method ref		
Client Sample No												
Client Sample ID	BH01	BH01	BH02	BH03	BH03	BH04	BH05	BH05				
Depth to Top	0.40	0.80	0.50	0.50	1.00	0.30	0.40	1.10				
Depth To Bottom		1.20			1.30			1.40				
Date Sampled	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17				
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D				
Sample Matrix Code	5A	5A	6AB	4AB	5	4A	4A	5A				
% Stones >10mm <sup>#</sup>	<0.1	<0.1	19.5	19.0	<0.1	5.9	15.0	<0.1			% w/w	A-T-044
pH <sup>M#</sup>	-	5.03	-	-	6.61	-	-	5.36	pH	A-T-031s		
Sulphate (water sol 2:1) <sub>D</sub> <sup>M#</sup>	-	0.03	-	-	0.02	-	-	0.03	g/l	A-T-026s		
Organic matter <sub>D</sub> <sup>M#</sup>	2.9	-	14.7	5.2	-	5.7	4.3	-	% w/w	A-T-032 OM		
Arsenic <sub>D</sub> <sup>M#</sup>	8	-	17	23	-	20	11	-	mg/kg	A-T-024s		
Cadmium <sub>D</sub> <sup>M#</sup>	0.9	-	0.9	0.6	-	1.0	0.5	-	mg/kg	A-T-024s		
Copper <sub>D</sub> <sup>M#</sup>	28	-	381	32	-	35	22	-	mg/kg	A-T-024s		
Chromium <sub>D</sub> <sup>M#</sup>	18	-	13	9	-	15	11	-	mg/kg	A-T-024s		
Lead <sub>D</sub> <sup>M#</sup>	55	-	105	96	-	164	56	-	mg/kg	A-T-024s		
Mercury <sub>D</sub>	<0.17	-	<0.17	<0.17	-	<0.17	<0.17	-	mg/kg	A-T-024s		
Nickel <sub>D</sub> <sup>M#</sup>	20	-	29	21	-	22	16	-	mg/kg	A-T-024s		
Selenium <sub>D</sub>	<1	-	<1	<1	-	<1	<1	-	mg/kg	A-T-024s		
Zinc <sub>D</sub> <sup>M#</sup>	96	-	99	78	-	119	73	-	mg/kg	A-T-024s		
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 <sub>A</sub> <sup>#</sup>	-	Appended	-	-	Appended	-	-	Appended		Subcon		
1.01 % Moisture BS1377 1990 pt2 cl3.2 <sub>A</sub> <sup>#</sup>	-	Appended	-	-	Appended	-	-	Appended		Subcon		

Envirolab Job Number: 17/04115

Client Project Name: Land Adj to Three Horse Shoes, Brierley

Client Project Ref: 13187-5001

Lab Sample ID	17/04115/1	17/04115/2	17/04115/3	17/04115/4	17/04115/5	17/04115/6	17/04115/7	17/04115/8	Units	Method ref		
Client Sample No												
Client Sample ID	BH01	BH01	BH02	BH03	BH03	BH04	BH05	BH05				
Depth to Top	0.40	0.80	0.50	0.50	1.00	0.30	0.40	1.10				
Depth To Bottom		1.20			1.30			1.40				
Date Sampled	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17				
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D				
Sample Matrix Code	5A	5A	6AB	4AB	5	4A	4A	5A				
Asbestos in Soil (inc. matrix)												
Asbestos in soil <sup>#</sup>	NAD	-	NAD	NAD	-	NAD	NAD	-		A-T-045		
Asbestos ACM - Suitable for Water Absorption Test?	N/A	-	N/A	N/A	-	N/A	N/A	-				

Envirolab Job Number: 17/04115

Client Project Name: Land Adj to Three Horse Shoes, Brierley

Client Project Ref: 13187-5001

Lab Sample ID	17/04115/1	17/04115/2	17/04115/3	17/04115/4	17/04115/5	17/04115/6	17/04115/7	17/04115/8	Units	Method ref		
Client Sample No												
Client Sample ID	BH01	BH01	BH02	BH03	BH03	BH04	BH05	BH05				
Depth to Top	0.40	0.80	0.50	0.50	1.00	0.30	0.40	1.10				
Depth To Bottom		1.20			1.30			1.40				
Date Sampled	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17				
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D				
Sample Matrix Code	5A	5A	6AB	4AB	5	4A	4A	5A				
PAH 16												
Acenaphthene <sub>A</sub> <sup>M#</sup>	<0.01	-	<0.01	0.02	-	0.01	<0.01	-	mg/kg	A-T-019s		
Acenaphthylene <sub>A</sub> <sup>M#</sup>	<0.01	-	<0.01	0.10	-	0.01	0.01	-	mg/kg	A-T-019s		
Anthracene <sub>A</sub> <sup>M#</sup>	<0.02	-	0.04	0.37	-	0.08	0.05	-	mg/kg	A-T-019s		
Benzo(a)anthracene <sub>A</sub> <sup>M#</sup>	<0.04	-	0.35	3.03	-	0.46	0.31	-	mg/kg	A-T-019s		
Benzo(a)pyrene <sub>A</sub> <sup>M#</sup>	<0.04	-	0.38	2.02	-	0.44	0.28	-	mg/kg	A-T-019s		
Benzo(b)fluoranthene <sub>A</sub> <sup>M#</sup>	<0.05	-	0.48	2.41	-	0.52	0.33	-	mg/kg	A-T-019s		
Benzo(ghi)perylene <sub>A</sub> <sup>M#</sup>	<0.05	-	0.30	0.79	-	0.27	0.14	-	mg/kg	A-T-019s		
Benzo(k)fluoranthene <sub>A</sub> <sup>M#</sup>	<0.07	-	0.16	1.00	-	0.21	0.10	-	mg/kg	A-T-019s		
Chrysene <sub>A</sub> <sup>M#</sup>	<0.06	-	0.38	2.52	-	0.50	0.30	-	mg/kg	A-T-019s		
Dibenzo(ah)anthracene <sub>A</sub> <sup>M#</sup>	<0.04	-	0.07	0.28	-	0.08	0.04	-	mg/kg	A-T-019s		
Fluoranthene <sub>A</sub> <sup>M#</sup>	<0.08	-	0.54	5.14	-	0.85	0.44	-	mg/kg	A-T-019s		
Fluorene <sub>A</sub> <sup>M#</sup>	<0.01	-	<0.01	0.07	-	0.01	0.01	-	mg/kg	A-T-019s		
Indeno(123-cd)pyrene <sub>A</sub> <sup>M#</sup>	0.05	-	0.33	1.12	-	0.32	0.18	-	mg/kg	A-T-019s		
Naphthalene <sub>A</sub> <sup>M#</sup>	<0.03	-	0.04	<0.03	-	<0.03	<0.03	-	mg/kg	A-T-019s		
Phenanthrene <sub>A</sub> <sup>M#</sup>	<0.03	-	0.18	1.16	-	0.34	0.17	-	mg/kg	A-T-019s		
Pyrene <sub>A</sub> <sup>M#</sup>	<0.07	-	0.52	4.71	-	0.75	0.39	-	mg/kg	A-T-019s		
PAH (total 16) <sub>A</sub> <sup>M#</sup>	<0.08	-	3.78	24.7	-	4.86	2.77	-	mg/kg	A-T-019s		

Envirolab Job Number: 17/04115

Client Project Name: Land Adj to Three Horse Shoes, Brierley

Client Project Ref: 13187-5001

Lab Sample ID	17/04115/1	17/04115/2	17/04115/3	17/04115/4	17/04115/5	17/04115/6	17/04115/7	17/04115/8	Units	Method ref		
Client Sample No												
Client Sample ID	BH01	BH01	BH02	BH03	BH03	BH04	BH05	BH05				
Depth to Top	0.40	0.80	0.50	0.50	1.00	0.30	0.40	1.10				
Depth To Bottom		1.20			1.30			1.40				
Date Sampled	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17	14-Jun-17				
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D				
Sample Matrix Code	5A	5A	6AB	4AB	5	4A	4A	5A				
TPH CWG												
Ali >C5-C6 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Ali >C6-C8 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Ali >C8-C10 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Ali >C10-C12 <sub>A</sub> <sup>#</sup>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Ali >C12-C16 <sub>A</sub> <sup>#</sup>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Ali >C16-C21 <sub>A</sub> <sup>#</sup>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Ali >C21-C35 <sub>A</sub> <sup>#</sup>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Total Aliphatics <sub>A</sub>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Aro >C5-C7 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Aro >C7-C8 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Aro >C8-C9 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Aro >C9-C10 <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
Aro >C10-C12 <sub>A</sub> <sup>#</sup>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Aro >C12-C16 <sub>A</sub> <sup>#</sup>	<0.1	-	-	<0.1	-	-	<0.1	-	mg/kg	A-T-023s		
Aro >C16-C21 <sub>A</sub> <sup>#</sup>	<0.1	-	-	2.6	-	-	0.5	-	mg/kg	A-T-023s		
Aro >C21-C35 <sub>A</sub> <sup>#</sup>	<0.1	-	-	3.5	-	-	0.3	-	mg/kg	A-T-023s		
Total Aromatics <sub>A</sub>	<0.1	-	-	6.0	-	-	0.8	-	mg/kg	A-T-023s		
TPH (Ali & Aro) <sub>A</sub>	<0.1	-	-	6.0	-	-	0.8	-	mg/kg	A-T-023s		
BTEX - Benzene <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
BTEX - Toluene <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
BTEX - Ethyl Benzene <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
BTEX - m & p Xylene <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
BTEX - o Xylene <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		
MTBE <sub>A</sub> <sup>#</sup>	<0.01	-	-	<0.01	-	-	<0.01	-	mg/kg	A-T-022s		

## **REPORT NOTES**

### **General:**

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

### **Soil chemical analysis:**

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

### **TPH analysis of water by method A-T-007:**

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

### **Electrical Conductivity of water by Method A-T-037:**

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

### **Asbestos:**

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

### **Predominant Matrix Codes:**

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

### **Secondary Matrix Codes:**

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

### **Key:**

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.



## Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR  
Tel. 0161 368 4921 email. ask@envlab.co.uk

**Client:** MET Engineers Ltd, Southgate House, Pontefract Road, Leeds, LS10 1SW

**Project No:** 17/04115

**Date Instructions Received:** 16/06/2017 (am)

**Project:** Land Adj to Three Horse Shoes, Brierley

**Clients Project No:** 13187-5001

NO DEVIATIONS IDENTIFIED

## Appendix V

Gas Monitoring Results and Gas Monitor Calibration  
Certificates



**MET Engineers Ltd**  
 Southgate House, Pontefract Road,  
 Leeds, W. Yorkshire, LS10 1SW  
 Tel: 0113 200 8900 Fax: 0113 200 8901  
 Web: www.metengineers.com

### Gas Monitoring Record

Client	Groom Design Services Ltd
Project No.	13187/5001
Project Title:	Land Adj to Three Horse Shoes
Borehole No:	BH01
Response Zone:	0.5-1.9mbgl
Grid Reference:	440688, 411234
Equipment:	Geo Tech GA5000

Date	Time	Weather	CH <sub>4</sub> (%)	CO <sub>2</sub> (%)	O <sub>2</sub> (%)	H <sub>2</sub> S (%)	CO (ppm)	Balance (%)	Atmospheric Pressure (mb)	Relative Pressure (mb)	Pressure Trend*	Flow (l/h)	Water (mBGL)	BH Depth (mBGL)
22.06.17	11.52	Cloudy	0	4.8	17.3	0	3	77.9	998	0.21	↑	0.3	Dry	1.9
11.07.17	15.51	Raining	0	6.6	15.7	0	0	77.7	997	-0.35	↓	0.3	1.86	1.9

\* Pressure trend taken from nearest Met Office observation point.



**MET Engineers Ltd**  
 Southgate House, Pontefract Road,  
 Leeds, W. Yorkshire, LS10 1SW  
 Tel: 0113 200 8900 Fax: 0113 200 8901  
 Web: www.metengineers.com

### Gas Monitoring Record

Client	Groom Design Services Ltd
Project No.	13187/5001
Project Title:	Land Adj to Three Horse Shoes
Borehole No:	BH03
Response Zone:	0.5-2.9mbgl
Grid Reference:	440721, 411233
Equipment:	Geo Tech GA5000

Date	Time	Weather	CH <sub>4</sub> (%)	CO <sub>2</sub> (%)	O <sub>2</sub> (%)	H <sub>2</sub> S (%)	CO (ppm)	Balance (%)	Atmospheric Pressure (mb)	Relative Pressure (mb)	Pressure Trend*	Flow (l/h)	Water (mBGL)	BH Depth (mBGL)
22.06.17	11.56	Cloudy	0	1	20.2	0	3	78.8	998	-0.05	↑	0.3	1.86	2.9
11.07.17	15.54	Raining	0	1	20.3	0	0	78.7	997	-0.02	↓	0.3	1.94	2.9

\* Pressure trend taken from nearest Met Office observation point.



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 Leeds, W. Yorkshire, LS10 1SW  
 Tel: 0113 200 8900 Fax: 0113 200 8901  
 Web: www.metengineers.com

### Gas Monitoring Record

Client	Groom Design Services Ltd
Project No.	13187/5001
Project Title:	Land Adj to Three Horse Shoes
Borehole No:	BH05
Response Zone:	0.5-2mbgl
Grid Reference:	440699, 411218
Equipment:	Geo Tech GA5000

Date	Time	Weather	CH <sub>4</sub> (%)	CO <sub>2</sub> (%)	O <sub>2</sub> (%)	H <sub>2</sub> S (%)	CO (ppm)	Balance (%)	Atmospheric Pressure (mb)	Relative Pressure (mb)	Pressure Trend*	Flow (l/h)	Water (mBGL)	BH Depth (mBGL)
22.06.17	12.00	Cloudy	0	4.1	17.5	0	4	78.4	998	-0.17	↑	0.3	Dry	2
11.07.17	15.58	Raining	0	8.5	11.7	0	0	79.8	997	-0.21	↓	0.3	Dry	2

\* Pressure trend taken from nearest Met Office observation point.

# CERTIFICATION OF CALIBRATION

Date Of Calibration: 09-Mar-2017 Certificate Number: G500155\_1/18056



ISSUED BY: GEOTECHNICAL INSTRUMENTS (UK) LTD

**Customer:** Met Engineers

Southgate House Pontefract Road LEEDS  
LS10 1SW UNITED KINGDOM

**Description:** Gas Analyser

**Model:** GA5000

**Serial Number:** G500155

## UKAS Accredited results:

Results after adjustment :

Methane (CH <sub>4</sub> )		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
5.1	5.0	0.41
15.0	15.0	0.64
50.0	49.4	0.94

Carbon Dioxide (CO <sub>2</sub> )		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
5.1	4.9	0.43
15.0	14.8	0.70
50.0	49.9	1.1

Oxygen (O <sub>2</sub> )		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
21.0	21.0	0.31

The inwards assessment was carried out 28-Feb-2017.

The maximum adjustment is larger than the inwards assessment uncertainty.

Inwards assessment data is available if requested.

All concentrations are molar.

CH<sub>4</sub>, CO<sub>2</sub> readings recorded at : 32.2 °C ± 1.5 °C

O<sub>2</sub> reading recorded at : 23.2 °C ± 1.5 °C

Barometric Pressure : 1014 mbar ± 3 mbar

Method of Test : The analyser is calibrated in a temperature controlled chamber using a series of reference gases, in compliance with procedure LP004.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

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# CERTIFICATION OF CALIBRATION

Date Of Calibration: 09-Mar-2017 Certificate Number: G500155\_1/18056



ISSUED BY: GEOTECHNICAL INSTRUMENTS (UK) LTD

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of  $k=2$ , providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Calibrations marked 'Non-UKAS Accredited results' on this certificate have been included for completeness.

## Non-UKAS Accredited results:

Barometer (mbar)	
Reference	Instrument Reading
1014	1015

Additional Gas Cells		
Gas	Certified Gas (ppm)	Instrument Reading (ppm)
H <sub>2</sub> S	259	259.1
CO	502	502.3

Internal Flow	
Applied (l/hr)	Instrument Reading (l/hr)
5	5
10	10.1

Approved by Signatory

Jeremy Dunn

Laboratory Inspection

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the Issuing laboratory.

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